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(54) **ANTI-STALL MECHANISM**

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E21B 4/00 (2006.01)

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CPC ... ***E21B 4/00*** (2013.01); ***E21B 4/06*** (2013.01); ***E21B 17/02*** (2013.01); ***E21B 17/046*** (2013.01); ***E21B 19/16*** (2013.01); ***F16D 11/16*** (2013.01); ***F16D 43/04*** (2013.01)

(58) **Field of Classification Search**

CPC F16D 43/14; F16D 43/16; F16D 11/16; F16D 2011/006; F16D 3/00; F16D 3/20; F16D 3/50; F16D 3/64; F16D 7/00; F16D 7/04; F16D 7/048; F16D 43/04; F16D 43/202; F16D 43/2028; F16D 43/22; F16D 43/24; E21B 4/006; E21B 4/02

See application file for complete search history.

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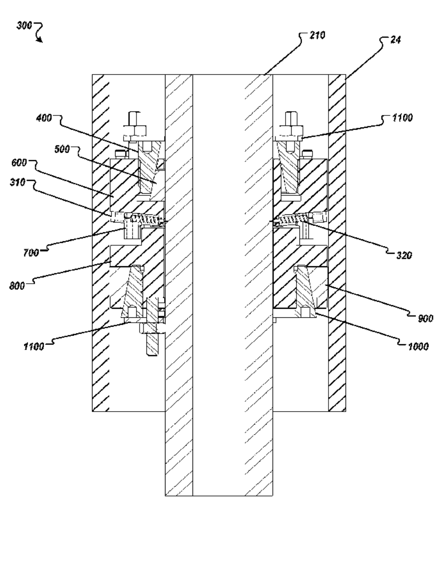
(57) **ABSTRACT**

The subject matter of this specification can be embodied in, among other things, a locking clutch that includes a collection of movable locking blocks slidably coupled to the rotatable output shaft. The movable locking blocks slide radially inwardly and outwardly with respect to a central longitudinal axis of the rotatable output shaft, and are spaced apart circumferentially about the rotatable output shaft, with each movable locking block having a first contacting face and a second contacting face. A collection of fixed locking blocks are coupled to the rotatable housing, and are positioned radially around the output shaft and spaced apart circumferentially about the interior of the rotatable housing a distance sufficient to receive one of the movable locking blocks when it moves inwardly toward the central axis of the rotatable output shaft, each said fixed locking block having a first contacting face and a second contacting face.

16 Claims, 14 Drawing Sheets



(51) **Int. Cl.**

F16D 43/04	(2006.01)
E21B 4/06	(2006.01)
E21B 17/02	(2006.01)
E21B 17/046	(2006.01)
E21B 19/16	(2006.01)

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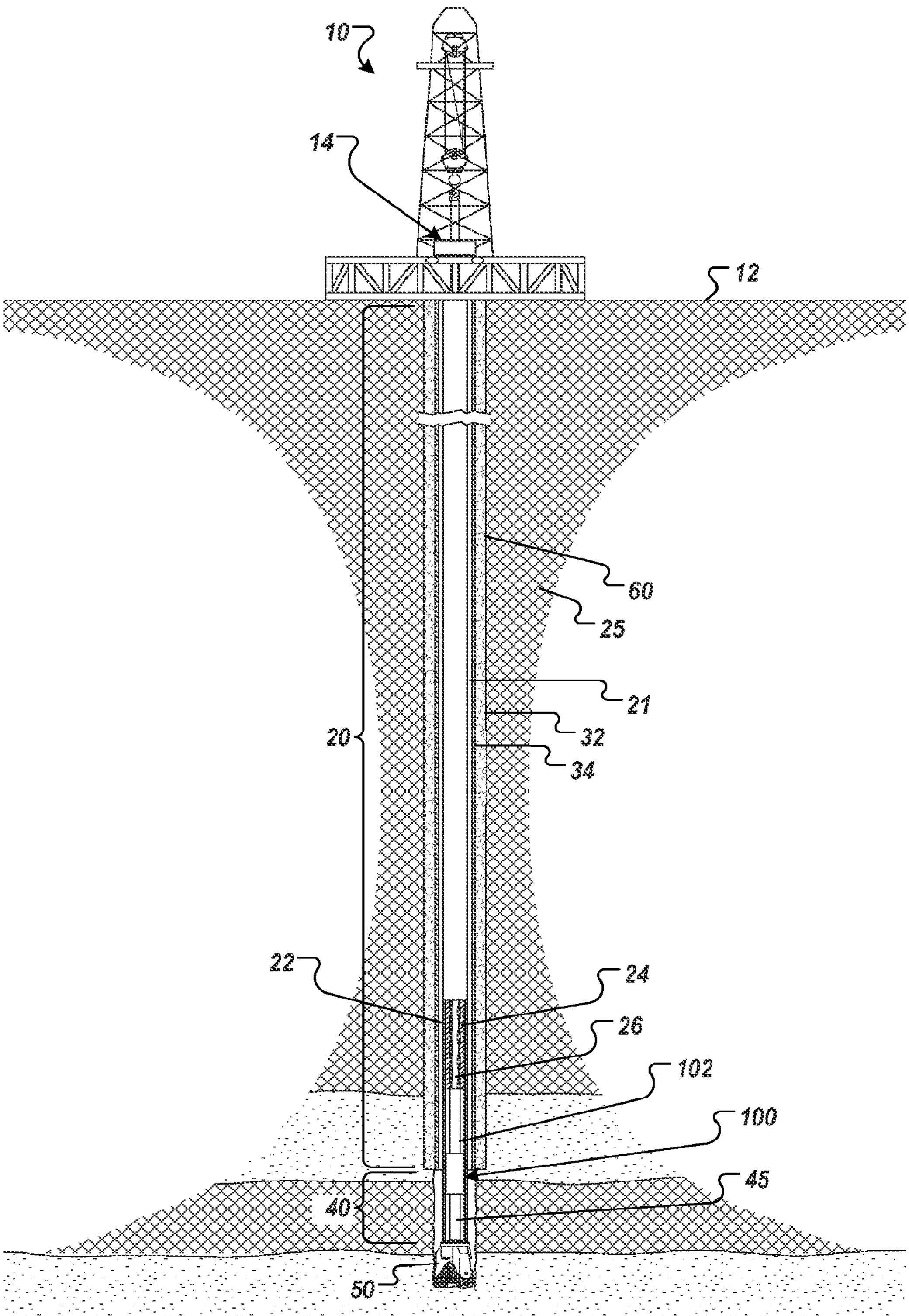


FIG. 1

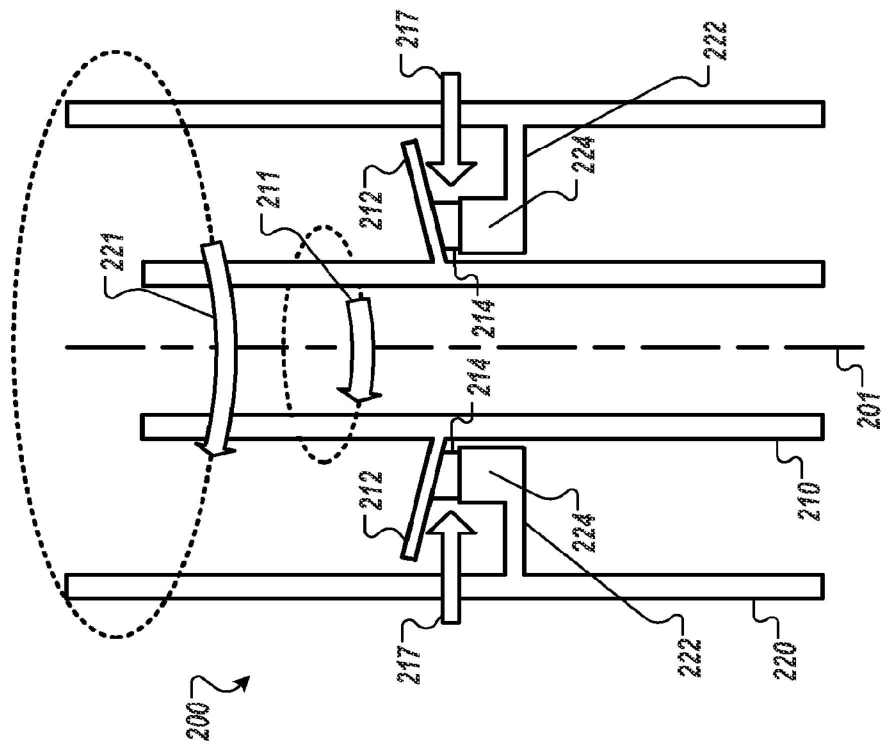
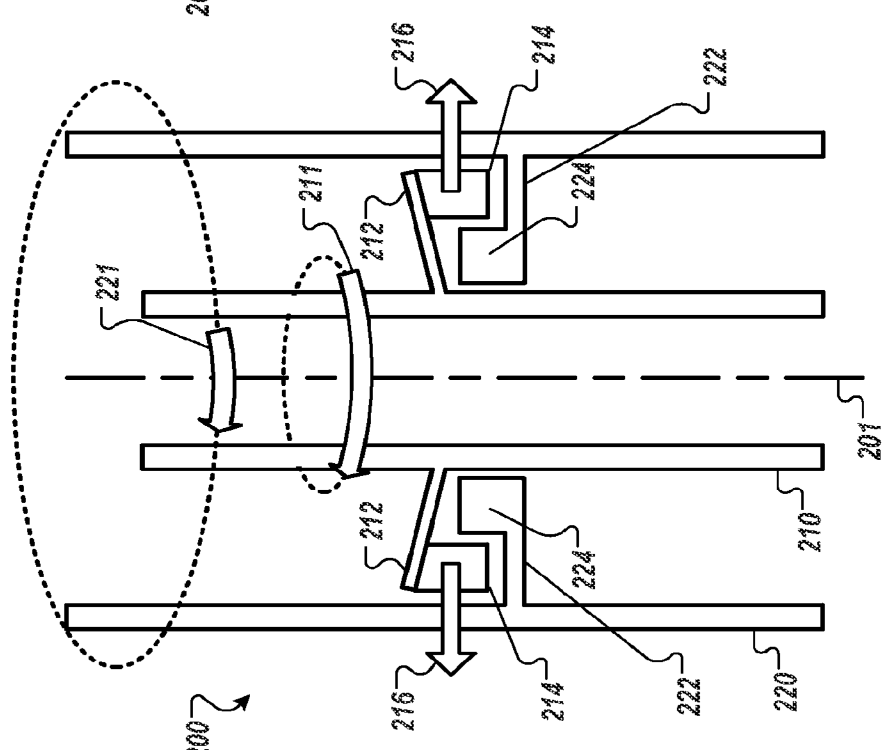

200
217
222
224
212
211
221
214
214
201
210
220

FIG. 2B


200
216
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212
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221
201
210
220

FIG. 2A

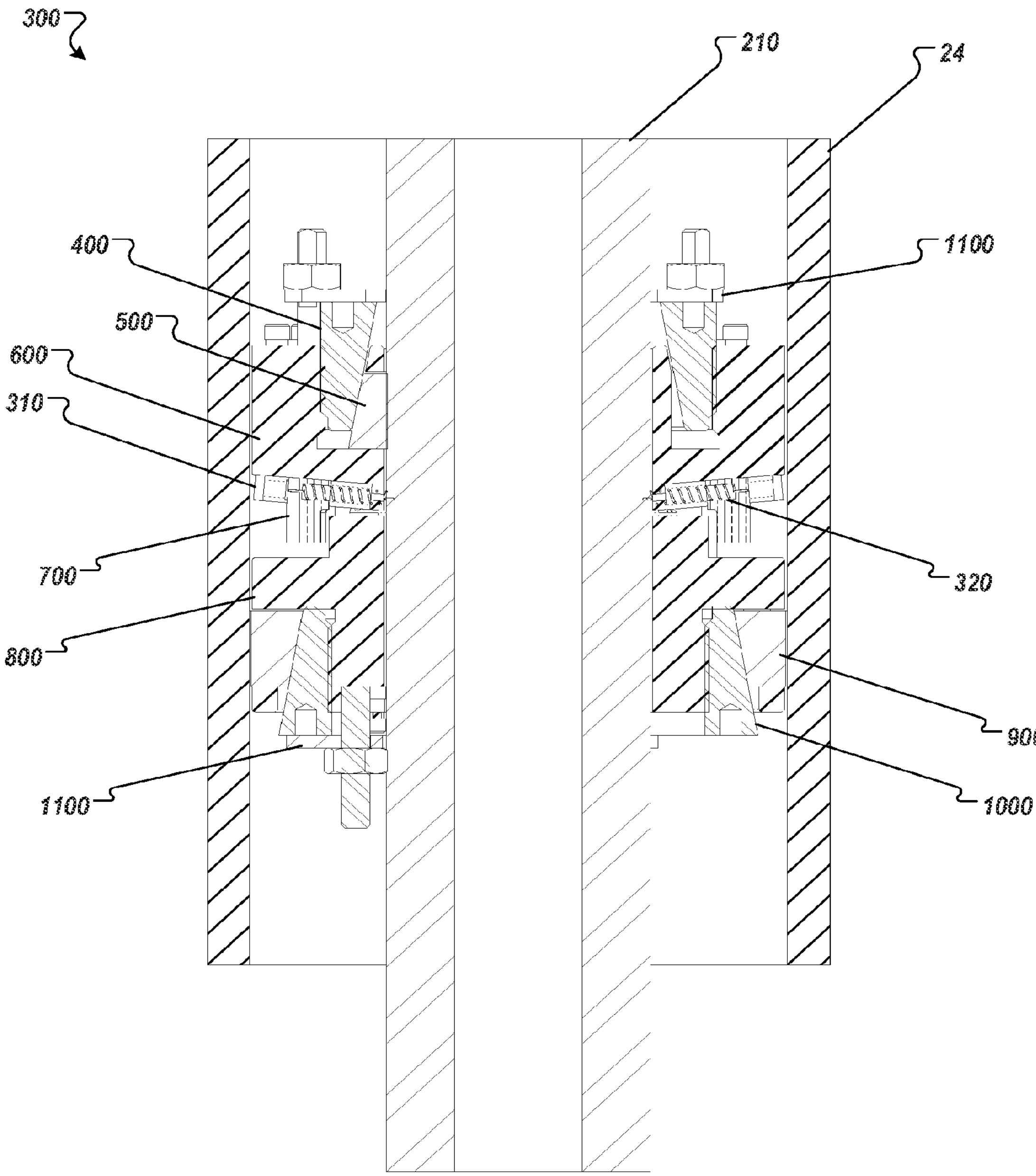


FIG. 3

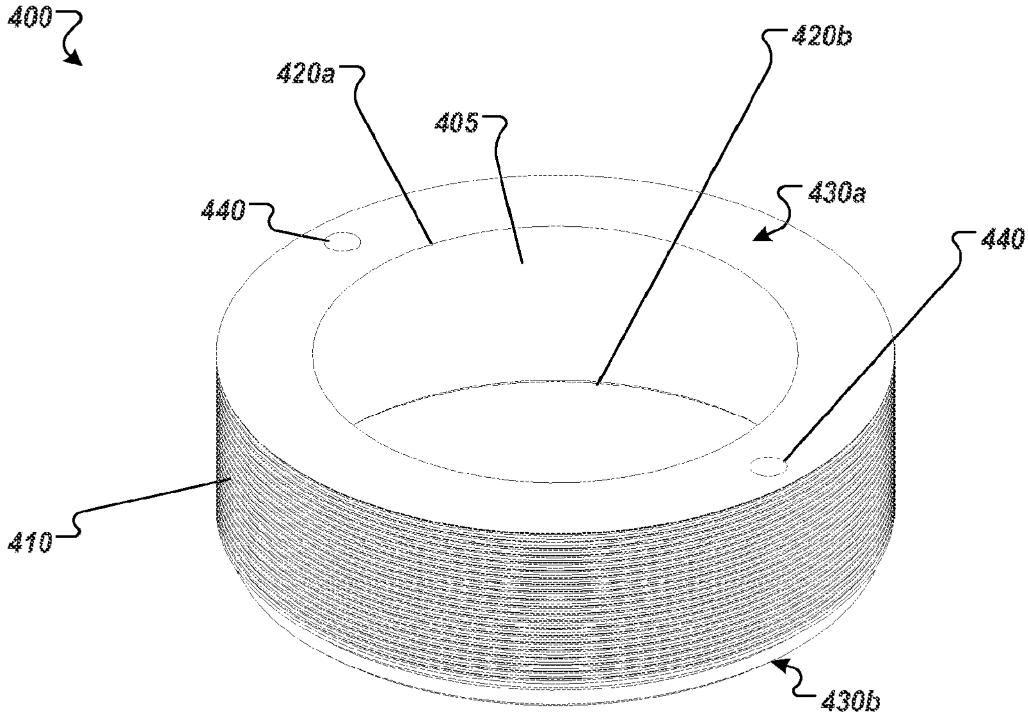

400
420a
405
420b
440
430a
440
410
430b

FIG. 4

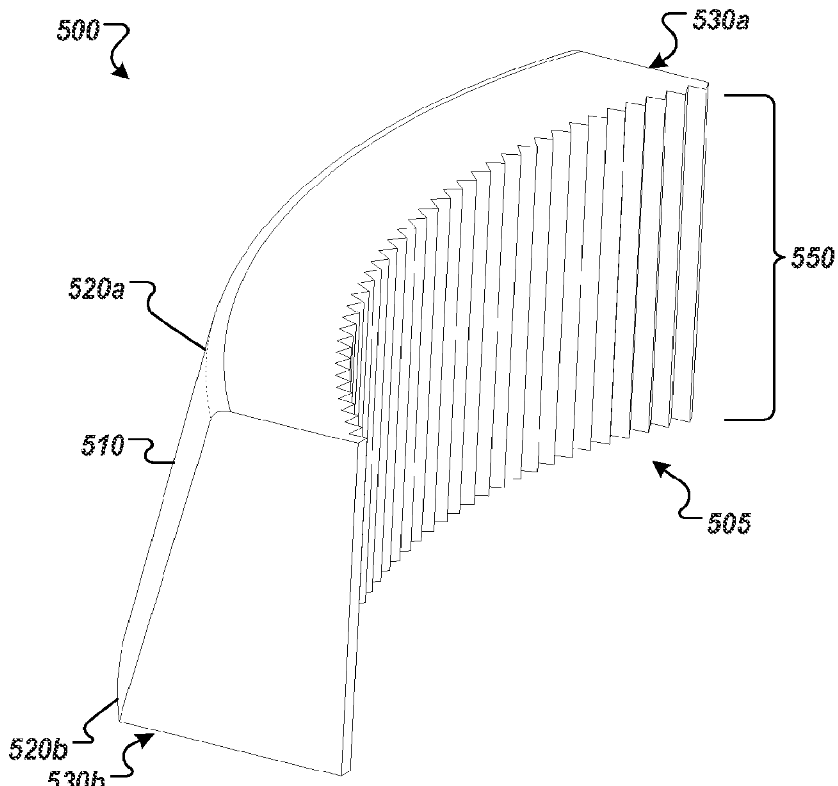

500
530a
550
520a
510
505
520b
530b

FIG. 5

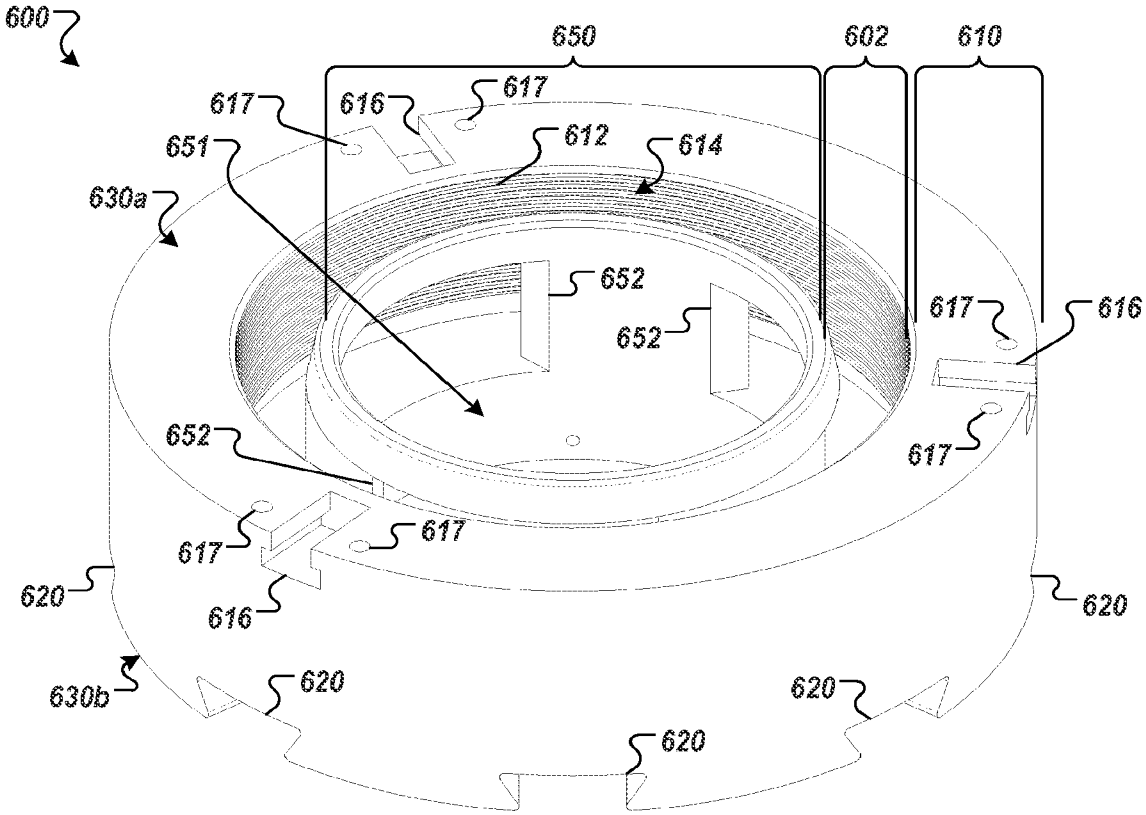

600
650
602
610
617
616
617
651
612
614
630a
652
652
617
616
617
652
617
617
616
620
620
630b
620
620
620

FIG. 6

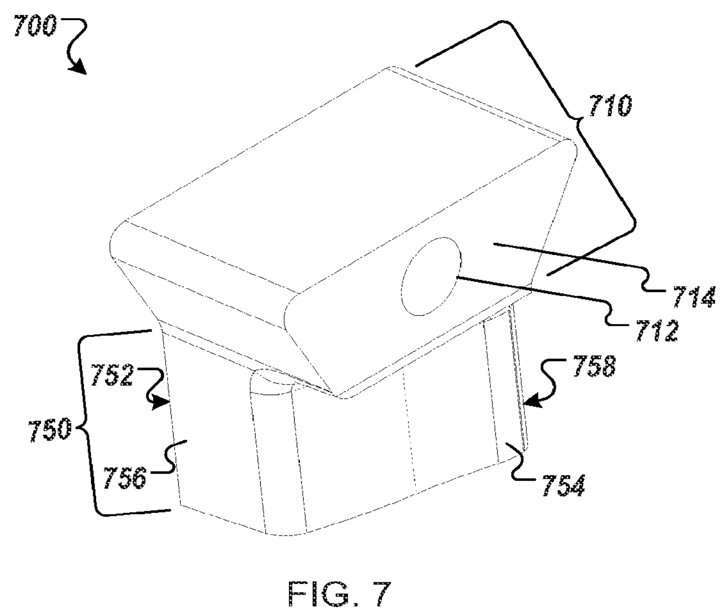

700
710
714
712
752
758
750
756
754

FIG. 7

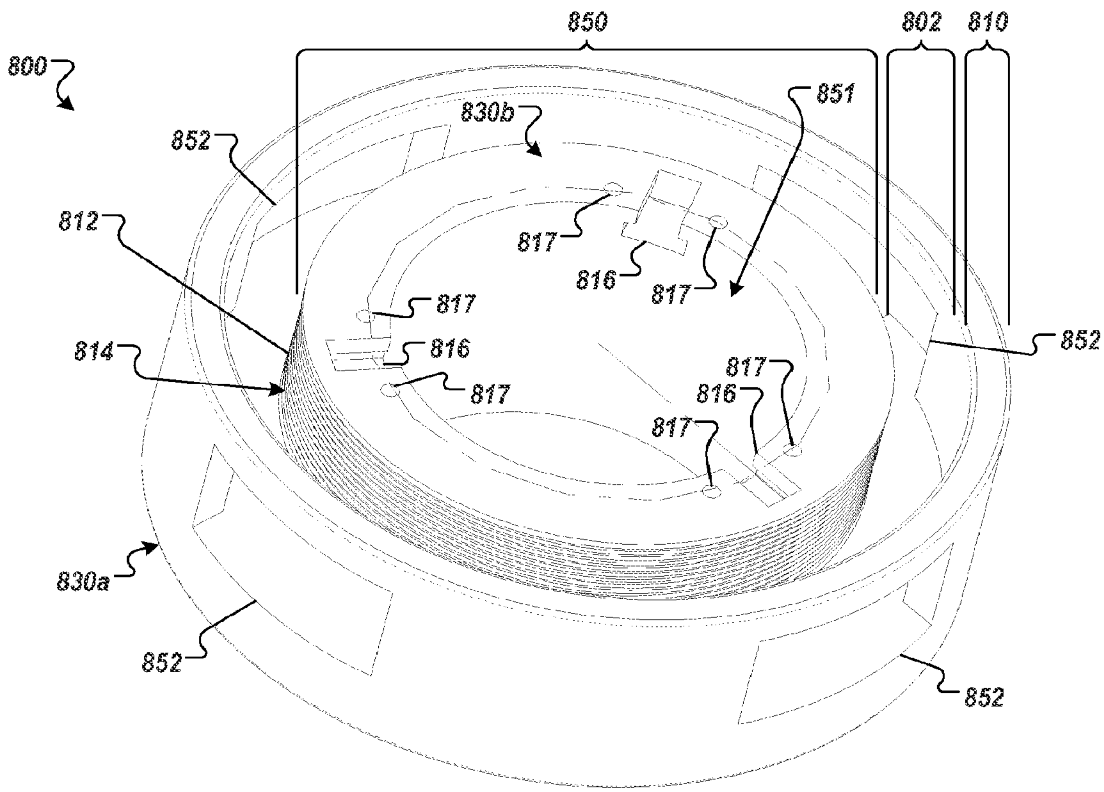
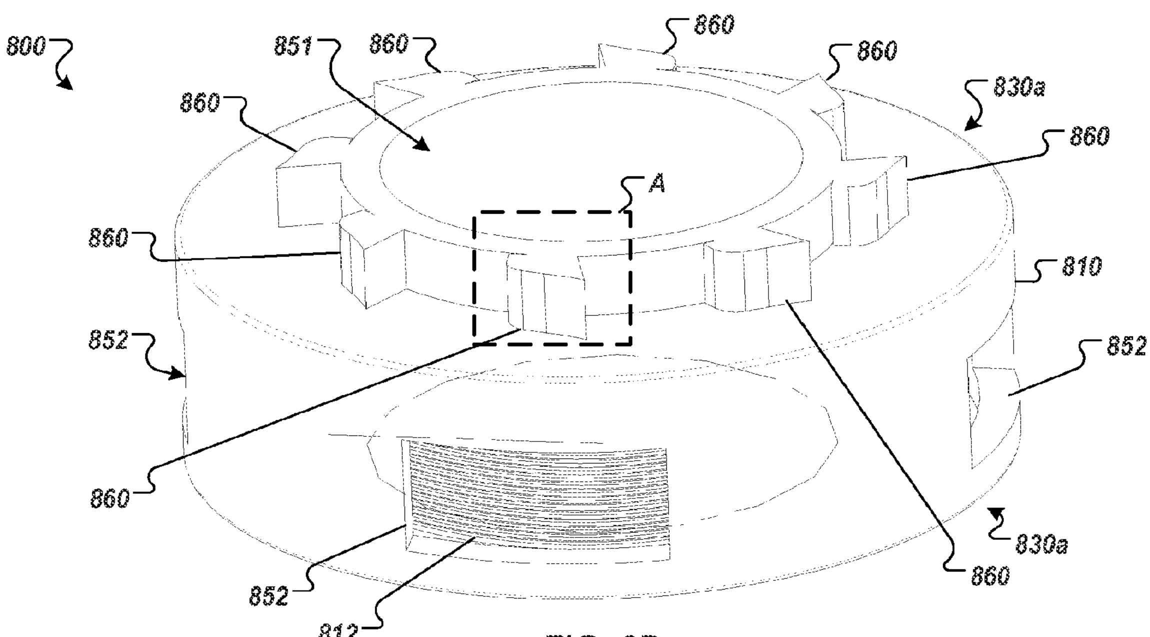

850
802
810
800
851
830b
852
812
817
816
817
817
816
852
814
817
817
816
817
830a
852
852

FIG. 8A


800
851
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830a
860
A
860
810
852
852
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830a
860
852
812

FIG. 8B

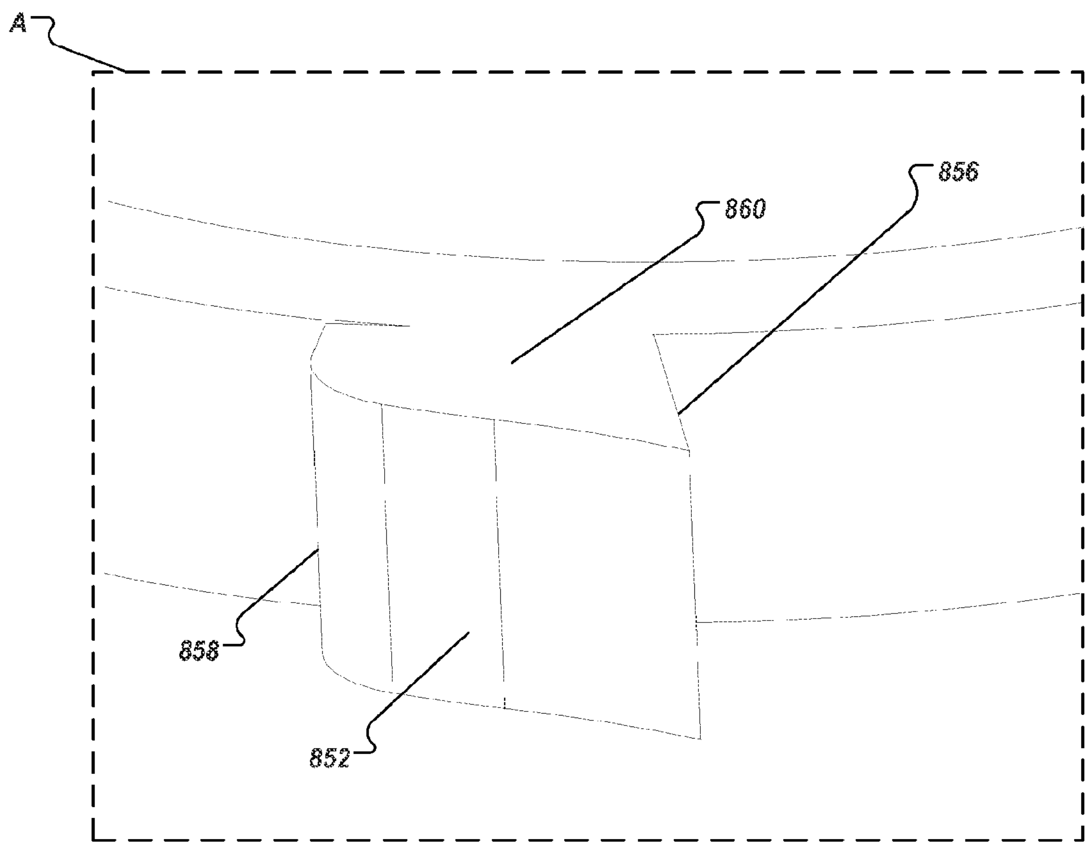

FIG. 8C

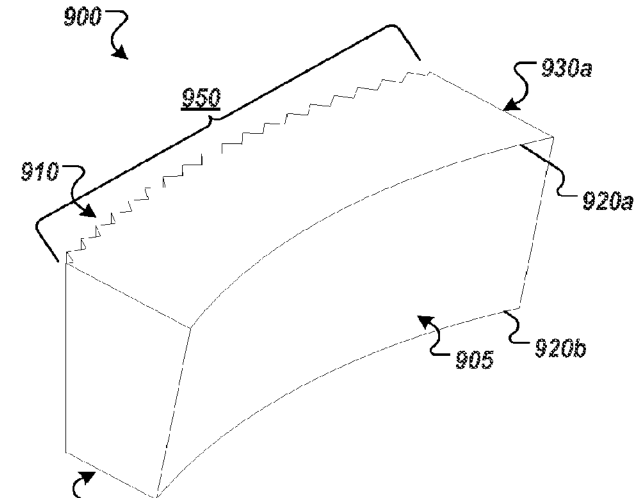

FIG. 9

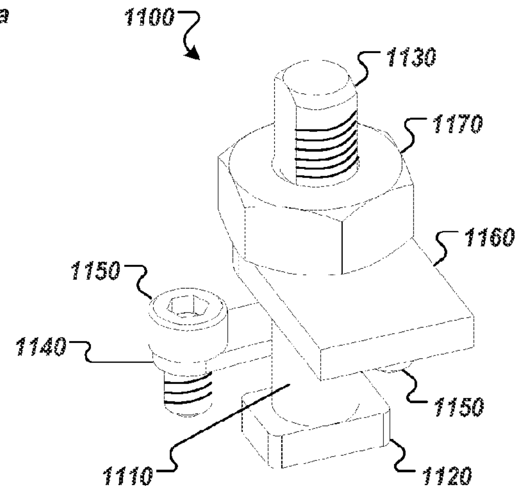

FIG. 11

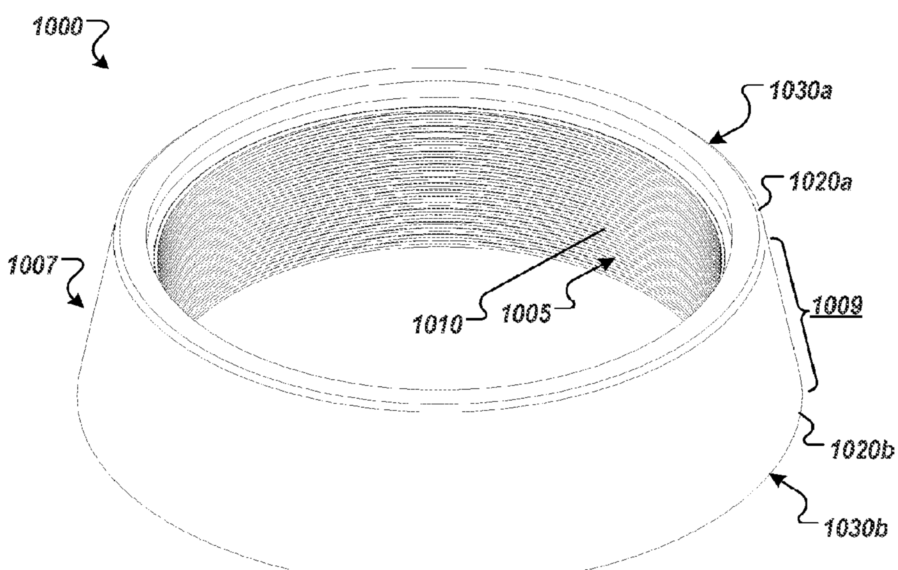

FIG. 10

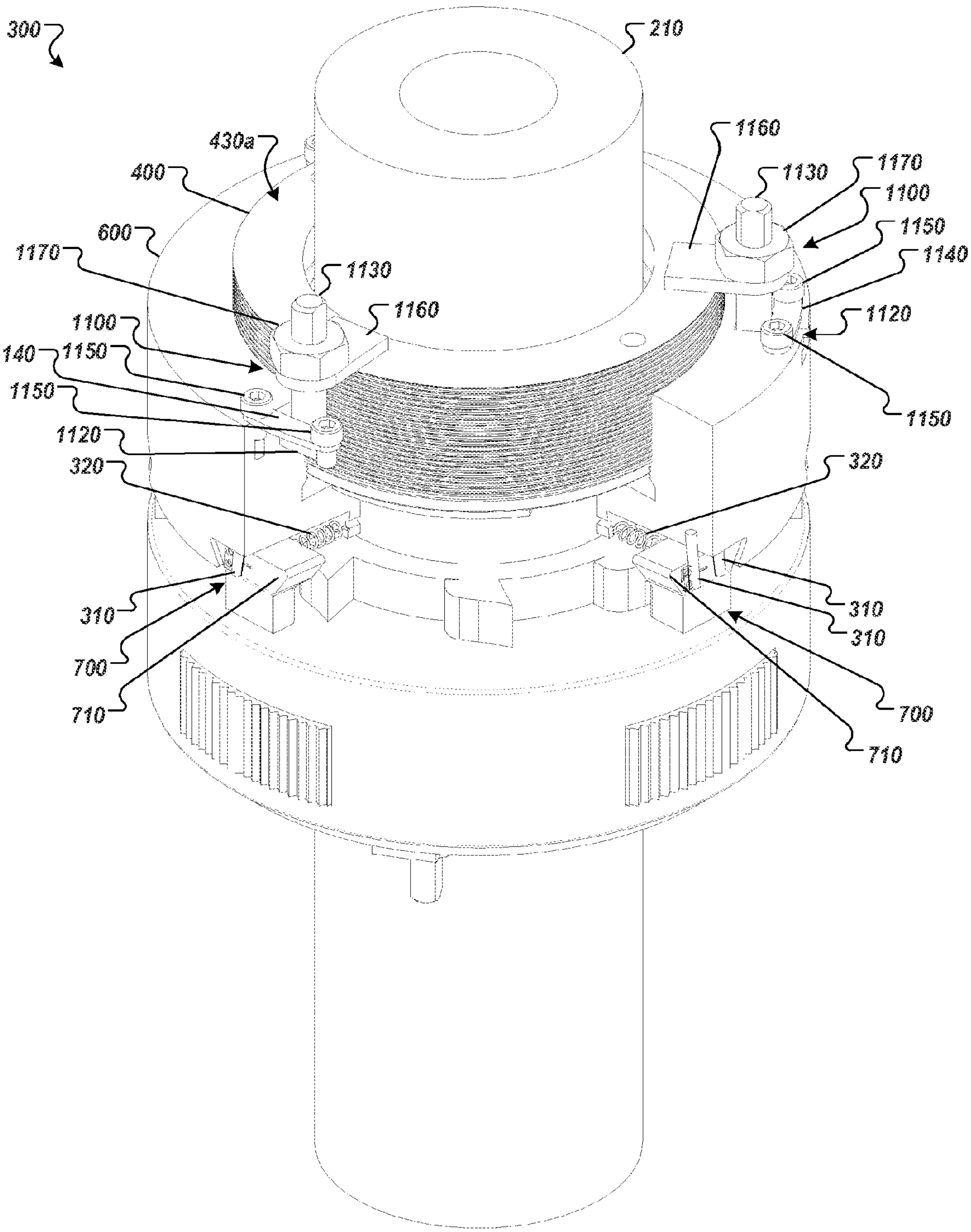
300
210
430a
400
600
1160
1130
1170
1100
1150
1140
1120
1150
1170
1130
1160
1100
1140
1150
1150
1120
320
320
310
310
310
700
700
710
710

FIG. 12A

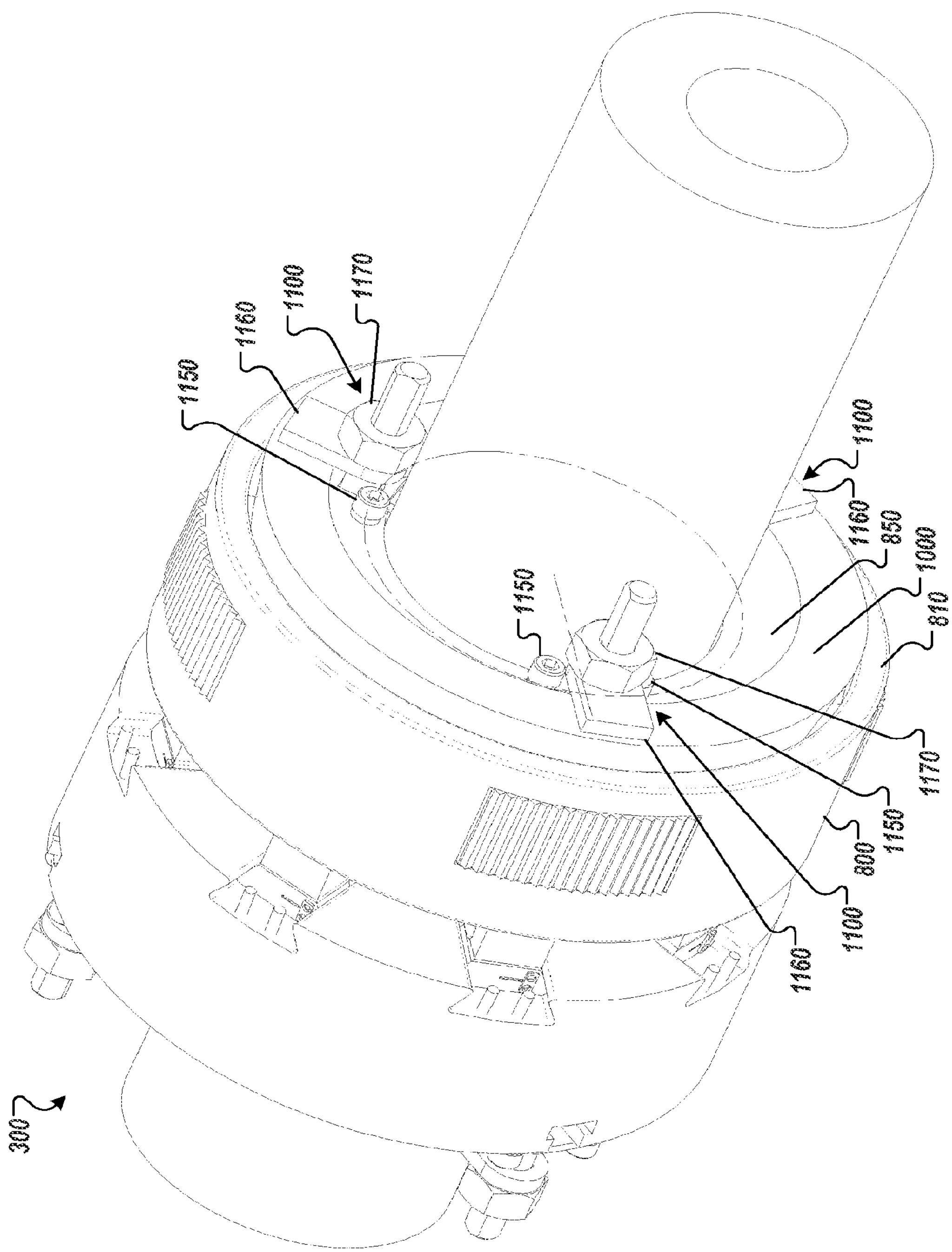
300
1150
1160
1100
1170
1150
1100
1160
850
1000
810
1170
1150
800
1100
1160

FIG. 12B

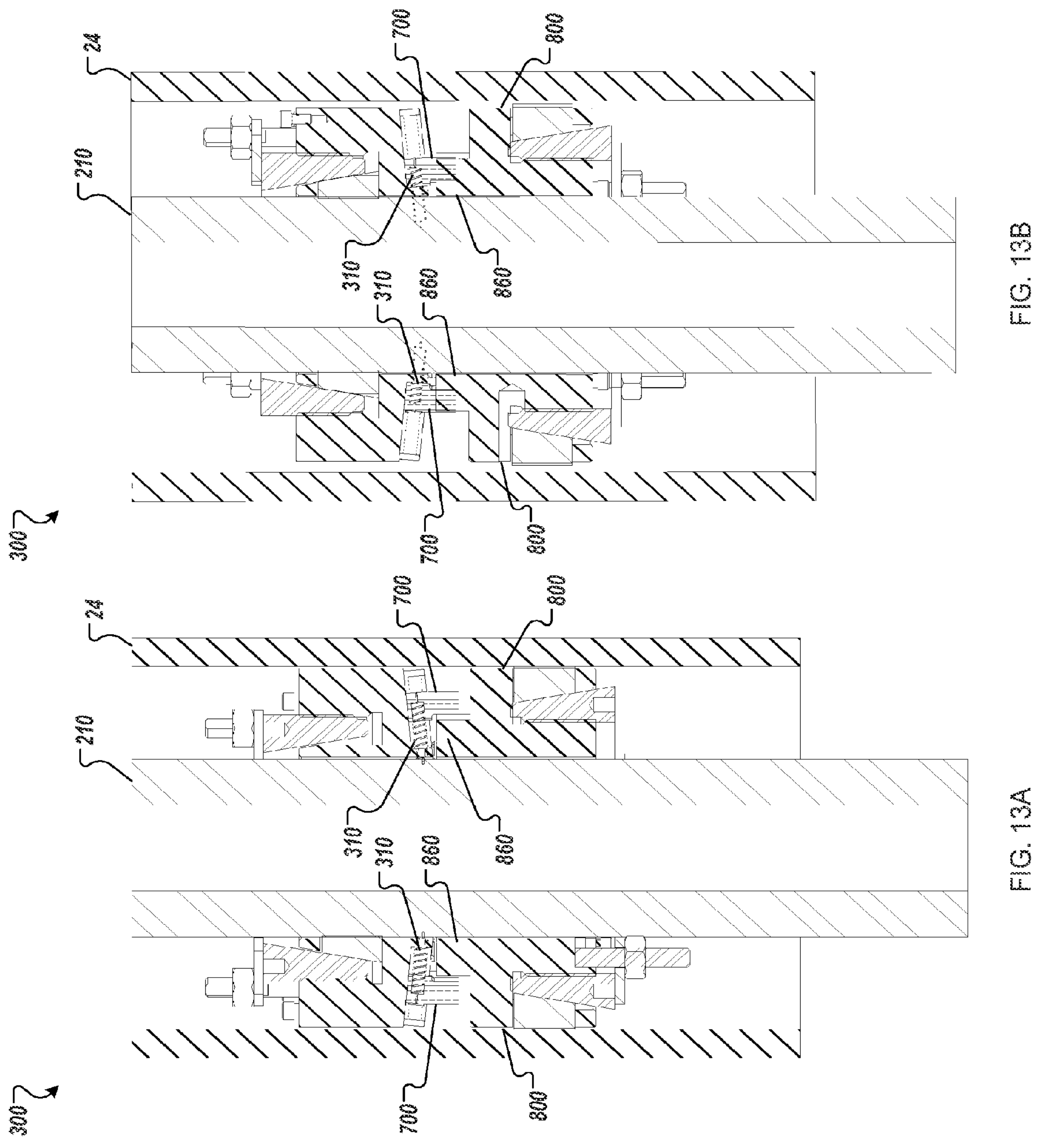

FIG. 13A

FIG. 13B

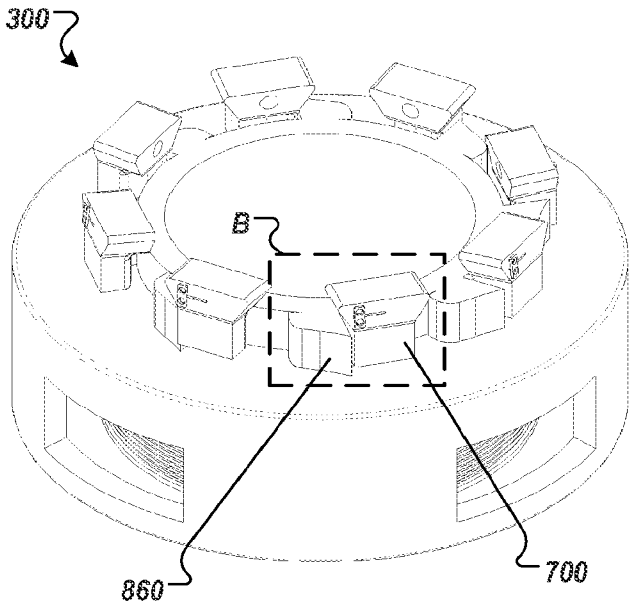

FIG. 14A

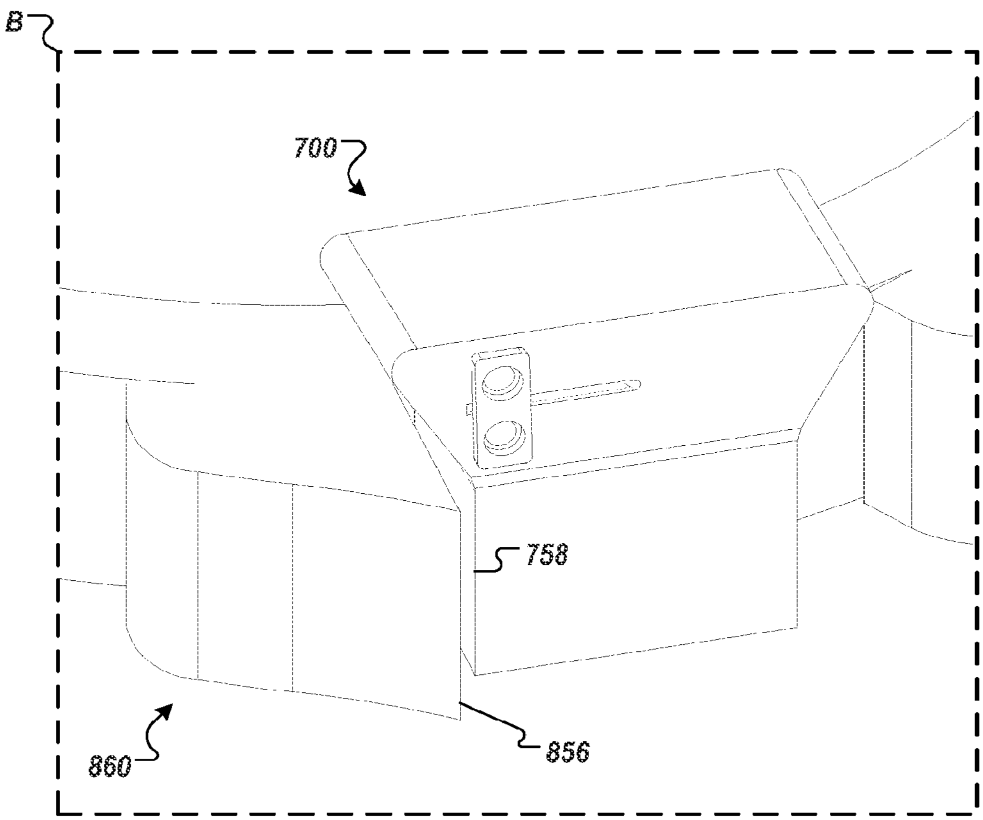

FIG. 14B

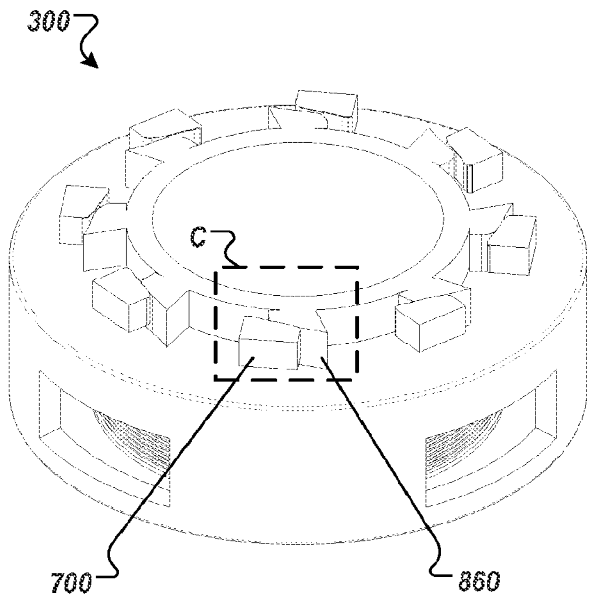

FIG. 15A

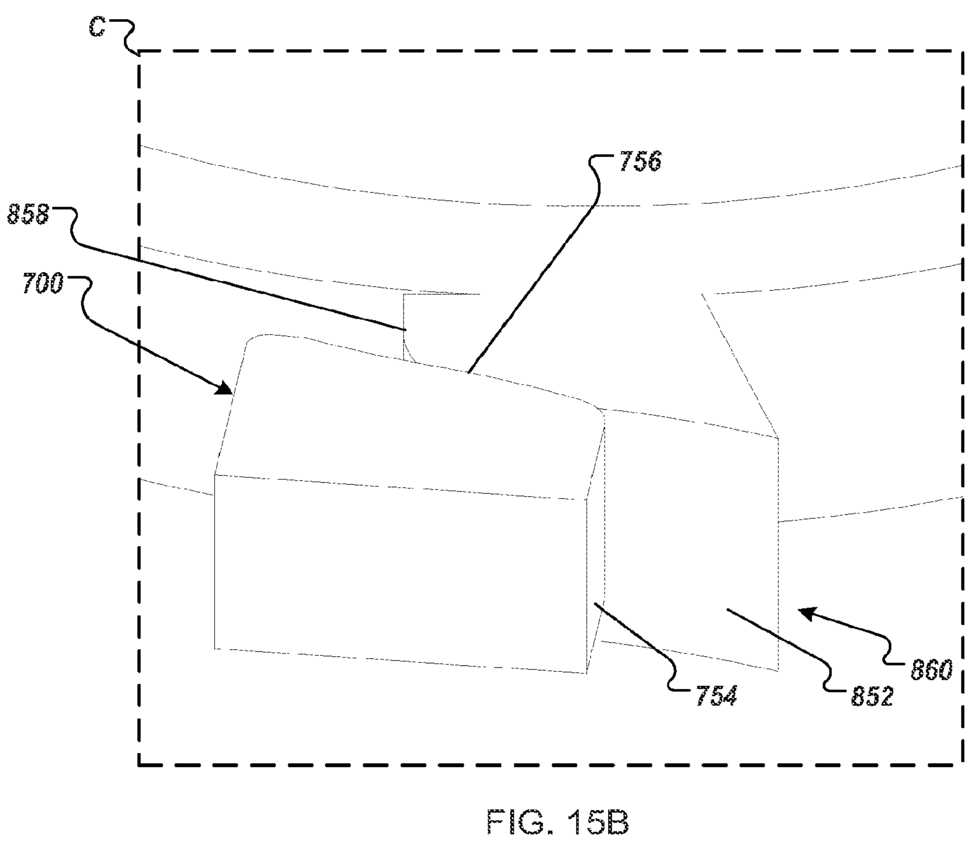

FIG. 15B

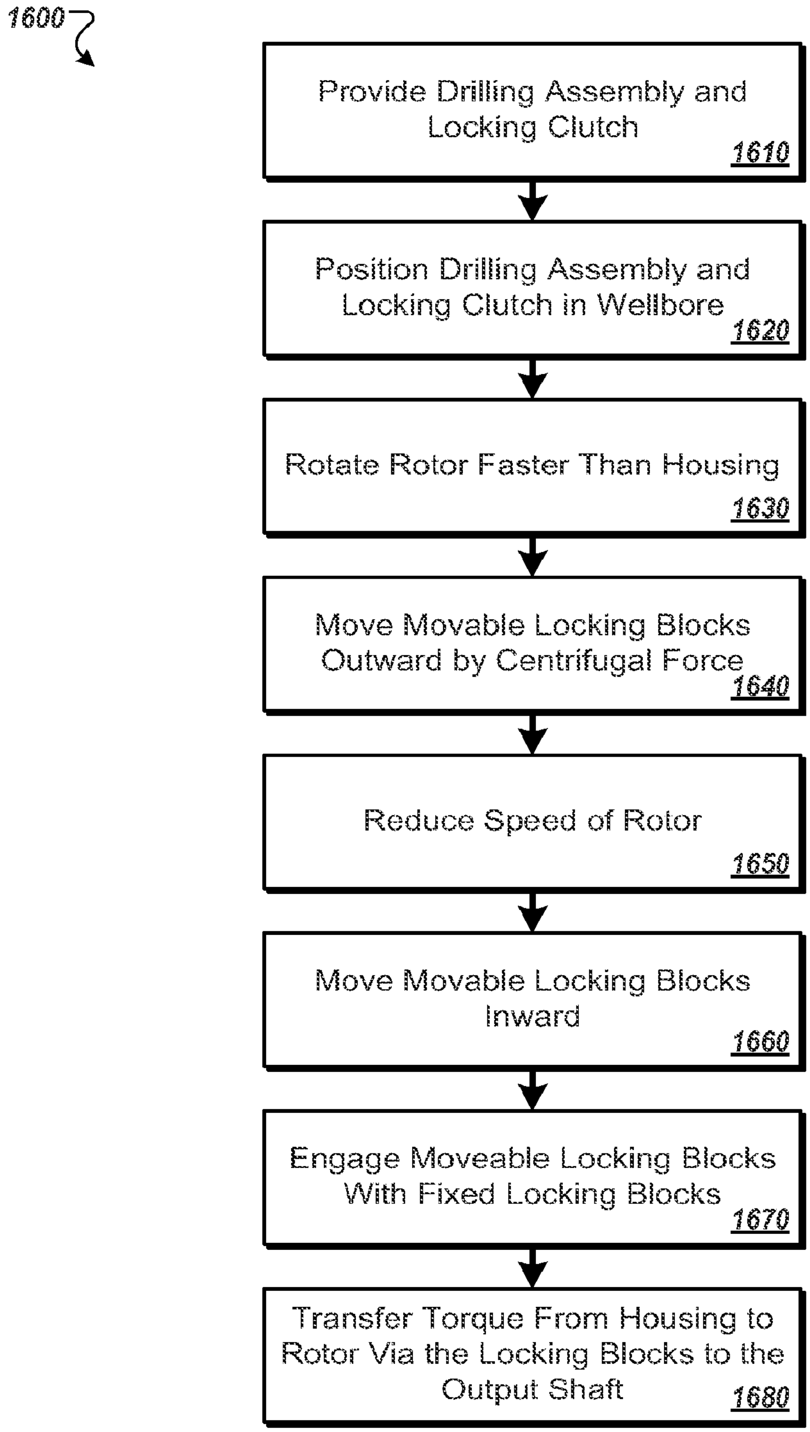
1600
Provide Drilling Assembly and Locking Clutch
1610
Position Drilling Assembly and Locking Clutch in Wellbore
1620
Rotate Rotor Faster Than Housing
1630
Move Movable Locking Blocks Outward by Centrifugal Force
1640
Reduce Speed of Rotor
1650
Move Movable Locking Blocks Inward
1660
Engage Moveable Locking Blocks With Fixed Locking Blocks
1670
Transfer Torque From Housing to Rotor Via the Locking Blocks to the Output Shaft
1680

FIG. 16

ANTI-STALL MECHANISM

CLAIM OF PRIORITY

This application is a US National Stage of PCT/US 2013/056499 filed on Aug. 23, 2013.

TECHNICAL FIELD

The present disclosure relates to systems, assemblies, and methods for an anti-stall mechanism (more particularly a locking clutch) for transmitting rotational torque to a tool string positioned in a wellbore.

BACKGROUND

In oil and gas exploration it is important to protect the operational progress of the drill string and downhole tools connected thereto. In general, a drilling rig located at or above the surface may be coupled to a proximate end of a drill string in a wellbore to rotate the drill string. The surface equipment on the drilling rig rotates the drill string. The drill string includes joints of drill pipe and may include a downhole power section coupled to the drill pipe (e.g., a positive displacement mud motor) that includes a stator and a rotor that are rotated and transfer torque down the borehole to a drill bit or other downhole equipment (referred to generally as the "tool string") coupled to a distal end of the drill string. During normal operation, the surface equipment rotates drill pipe that is coupled to the stator of the mud motor. The rotor is rotated due to a pumped fluid pressure difference across the power section relative to the stator. The rotational speed of downhole components, such as the drill string, power section, tool string, and drill bit, are commonly expressed in terms of revolutions per minute (RPM). As weight on the drill bit or formation resistance to drilling increases, the drill bit speed slows down. When the drill bit speed is equal to or less than the speed of the stator (as may be expressed in RPMs), the power section is referred to as "stalled."

DESCRIPTION OF DRAWINGS

FIG. **1** is a schematic illustration of a drilling rig and downhole equipment including a downhole drilling motor disposed in a wellbore.

FIGS. **2**A and **2**B are conceptual diagrams of an example of an anti-stall mechanism.

FIG. **3** is a cross-sectional side view of an example anti-stall mechanism.

FIG. **4** is a perspective view of an example upper taper disk.

FIG. **5** is a perspective view of an example upper wicker pad.

FIG. **6** is a perspective view of an example dovetail disk.

FIG. **7** is a perspective view of an example moveable locking block.

FIGS. **8**A, **8**B and **8**C are perspective views of an example locking disk.

FIG. **9** is a perspective view of an example lower wicker pad.

FIG. **10** is a perspective view of an example lower taper disk.

FIG. **11** is a perspective view of an example locking assembly.

FIG. **12**A is a partial cutaway perspective view of the example anti-stall mechanism.

FIG. **12**B is another perspective view of the example anti-stall mechanism.

FIG. **13**A is a cross-sectional side view of an example anti-stall mechanism in a disengaged configuration.

FIG. **13**B is a cross-sectional side view of an example anti-stall mechanism in an engaged configuration.

FIGS. **14**A-**14**B are perspective views of an example anti-stall mechanism in an engaged configuration.

FIGS. **15**A-**15**B are simplified perspective views of an example anti-stall mechanism exiting an engaged configuration.

FIG. **16** is a flow diagram of an example process for the operation of an example anti-stall mechanism.

DETAILED DESCRIPTION

Referring to FIG. **1**, in general, a drilling rig **10** located at or above the surface **12** rotates a drill string **20** disposed in a wellbore **60** below the surface **12**. The surface equipment **14** on the drilling rig rotates drill pipe **21**. The drill string **20** includes joints of drill pipe **21** and a downhole power section **22** (e.g., a downhole positive displacement motor such as a Moineau type motor), which includes a stator **24** and a rotor **26** that are rotated and transfer torque down the borehole to a drill bit **50** or other downhole equipment (referred to generally as the "tool string") **40** attached to a longitudinal output shaft **45** of the downhole positive displacement motor. The wellbore **60** is reinforced by a casing **34** and a cement sheath **32** in the annulus between the casing **34** and the borehole. During the normal operation, the surface equipment **14** rotates the drill pipe **21** which is coupled to the stator **24**, and the rotor **26** is rotated due to a pumped fluid pressure difference across the power section **22** relative to the stator **24** of a downhole positive displacement motor. As weight on the drill bit **50** or formation resistance to drilling increases, and when the torque generated by the power section is insufficient to overcome this resistance, the drill bit **50** speed slows down. When the drill bit **50** speed is equal to or less than the stator **24** RPM, the power section **22** is referred to as "stalled."

At this stage the rotation of the drill bit **50** and the rotor **26** lags behind the rotation of the stator **24**, which means the rotor **26** is turning relatively backward with respect to stator **24**. During motor stall, the combination of mechanical loading and high pressure fluid erosion can quickly result in serious damage to the elastomer of the stator and can reduce the working life and efficiency of the power section **22**.

Is some situations, motor stall may be avoided by providing additional torque to the drill bit **50** in order to cut through the formation that is causing the rotational resistance. In the illustrated example, an anti-stall mechanism **100** (also referred to as a locking clutch) is provided to transmit additional torque from the stator **24** to the drill bit **50**.

Under normal operation, the stator **24** and the rotor **26** are substantially rotationally decoupled from each other. Under stall or near-stall conditions, the anti-stall mechanism **100** engages to rotationally couple the stator **24** to an output drive shaft **102** that is driven by the rotor **26** to deliver additional torque to the longitudinal output shaft **45** which is removably secured to the output drive shaft. As resistance decreases, the anti-stall mechanism **100** disengages to substantially decouple the stator **24** from the rotor **26**. Although in the descriptions of FIGS. **1-16**, embodiments of the anti-stall mechanism **100** are described as being used in conjunction with Moineau-type drilling motors, in some embodiments the anti-stall mechanism **100** can also be used with turbines, turbodrills, or any other appropriate form of rotary power transfer mechanism.

FIGS. **2**A and **2**B are conceptual diagrams of an example of an anti-stall mechanism **200**. In some implementations, the anti-stall mechanism **200** can represent the anti-stall mechanism **100** of FIG. **1**. Referring to FIG. **2**A, an example of the anti-stall mechanism **200** operating under "normal" conditions is shown. Under "normal" conditions, a driveshaft **210** is rotated about a longitudinal axis **201** at a predetermined speed that is represented by the arrow **211**. The driveshaft **210** is generally rotated faster than the speed, represented by an arrow **221**, at which a stator **220** is rotated.

A collection of extensions **212** extend radially outward from the driveshaft **210**. Each of the extensions supports a moveable locking block **214** in a dovetail slot (not shown) that permits radial movement of the locking block **214**. As the driveshaft **210** spins, the moveable locking blocks **214** are urged radially outward by centrifugal forces. This outward movement is partly offset by a centripetal force applied to the moveable locking blocks **214**. In some embodiments, the centripetal force may be provided by gravity. For example, the dovetail slots may be inclined relative to the effects of gravity such that gravity will tend to draw the moveable locking blocks **214** downward and radially inward, in some embodiments, the centripetal force may be provided by mechanical components. For example, the moveable locking blocks **214** may be urged radially inward by springs, fluid action, or any other appropriate assembly that can provide a force that can urge the moveable locking blocks **214** radially inward.

When the driveshaft **210** is rotated faster than the predetermined speed, the centrifugal forces are sufficient to overcome the centripetal forces acting upon the moveable locking blocks **214**. Under such conditions, the moveable locking blocks **214** will be urged radially outward, as indicated by arrows **216**. When the moveable locking blocks **214** are at their substantially extended positions along the dovetail slots, the moveable locking blocks **214** are clear to orbit the axis **201** without contacting a collection of fixed locking blocks **224** supported by a collection of extensions **222** extending radially inward from the stator **220**.

Referring now to FIG. **2**B, an example of the anti-stall mechanism **200** operating under "stalled" conditions is shown. As the weight on the drill bit **50** is increased, or hard drilling conditions are encountered, the drill bit RPM decreases. At some stage the drill bit **50** speed may become sufficiently slow to consider the Moineau motor as being "stalled". Under "stalled" conditions, the driveshaft **210** is rotated about the longitudinal axis **201** below the predetermined speed represented by the arrow **211**. In the illustrated example, the driveshaft **210** is rotated more slowly than the speed at which a stator **220** is rotated, represented by the arrow **221**.

When the driveshaft **210** is rotated more slowly than the predetermined speed, the centrifugal forces are insufficient to overcome the centripetal forces acting upon the moveable locking blocks **214**. Under such conditions, the moveable locking blocks **214** will be urged radially inward, as indicated by arrows **217**. When the moveable locking blocks **214** are at their substantially retracted positions along the dovetail slots (e.g., in substantially the same orbit about the axis **201** as the fixed locking blocks), and the driveshaft **210** is rotating more slowly than the stator **220**, the moveable locking blocks **214** will contact the fixed locking blocks **224**. Rotational energy from the stator **220** will be transferred from the fixed locking blocks **224** to the moveable locking blocks **214**, thereby providing additional rotational energy to the driveshaft **210**.

In some implementations, the additional rotational energy transferred from the stator **220** to the driveshaft **210** may provide additional torque to the drill bit **50**. For example, the drill bit **50** may be lodged in an unexpectedly hard geological formation, and the additional torque may be sufficient to overcome the resistance of the formation and restart rotation of the drill bit. As the drill bit **50** speed and the driveshaft **210** speed increases, the moveable locking blocks **214** will return to the configuration shown in FIG. **2**A.

FIG. **3** is a cross-sectional side view of an example anti-stall mechanism **300**. In some implementations, the anti-stall mechanism **300** can be the anti-stall mechanism **100** of FIG. **1**. The anti-stall mechanism **300** includes an upper taper disk **400**, a collection of upper wicker pads **500**, a dovetail disk **600**, a collection of stopper pins **310**, a collection of springs **320**, a collection of moveable locking blocks **700**, a locking disk **800**, a collection of lower wicker pads **900**, a lower taper disk **1000**, and a collection of locking assemblies **1100**. The components **310**-**1100** will be discussed further in the descriptions of FIGS. **4**-**12**B.

FIG. **4** is a perspective view of the example upper taper disk **400**. The upper taper disk **400** is a ring with a collection of threads **410** about its outer diameter. An inner surface **405** of the taper disk is formed with a taper that progresses from a first diameter **420***a* at a first longitudinal end **430***a* and a second diameter **420***b* larger than the first diameter **420***a* at a second longitudinal end **430***b*.

The threads **410** are formed to mate with corresponding threads formed in the dovetail disk **600**, which will be discussed in the description of FIG. **5**. A collection of torque holes **440** are formed in the first longitudinal end **430***a*. In some implementations, the torque holes **440** may accept the insertion of a tool. For example, a spanner wrench may be inserted into the torque holes to rotate the upper taper disk **400** to thread or unthread the upper taper disk **400** to or from the dovetail disk **600**.

FIG. **5** is a perspective view of an example of the collection of upper wicker pads **500**. The upper wicker pad **500** is a section of a ring having an inner radial surface **505** and an outer radial surface **510**. The outer radial surface has a taper from a first diameter **520***a* and first longitudinal end **530***a* to a second diameter **520***b* at a second longitudinal end **530***b*. The degree of this taper is substantially equal to the taper of the upper taper disk **400**. The wicker pad **500** includes a collection of longitudinal wickers **550** on the inner radial surface **505**. In use, the longitudinal wickers **500** frictionally engage the driveshaft **210**. The longitudinal wickers **550** are compressed against the driveshaft **210** when the upper taper disk **400** is threaded into the dovetail disk **600**. In some embodiments, four upper wicker pads **500** may be included in the anti-stall mechanism **300**, although any appropriate number may be used.

FIG. **6** is a perspective view of the example dovetail disk **600**. The dovetail disk **600** is configured as an outer ring **610** arranged concentrically about and connected to an inner ring **650**, partly separated by a cavity **602**. The outer ring **610** includes a collection of threads **612** about an inner radial surface **614**. The threads **612** are configured to accept the threads **410** of the upper taper disk **400** when the upper taper disk **400** is assembled with (e.g., threaded into) the dovetail disk **600**.

The inner ring **650** includes a central bore **651** sized to accommodate the driveshaft **210**. The inner ring **650** includes a collection of slots **652** arranged radially about the circumference of the inner ring **650**. Each of the slots **652** is configured to accommodate one of the upper wicker pads **500**. As the upper taper disk **400** is assembled to the dovetail disk **600**, the upper wicker pads **500** are compressed between the upper taper disk **400** and the driveshaft **210**, causing the longitudinal wickers **550** to frictionally engage the driveshaft **210**.

The outer ring **610** includes a collection of locking slots **616** and fastener holes **617** formed in a first longitudinal end **630***a*. Each of the locking slots **616** and fastener holes **617** are configured to accommodate and removably affix a corresponding one of the locking assemblies **1100**, as will be discussed further in the descriptions of FIGS. **11** and **12**A.

The outer ring **610** also includes a collection of dovetail slots **620** formed radially about a second longitudinal end **630***b*. Each of the dovetail slots **620** is configured to accommodate a corresponding one of the moveable locking blocks **700**. The dovetail slots **620** are slightly tapered from the outer diameter of the outer ring **610** to a diameter radially inward from the outer diameter. In some embodiments, the taper in the dovetail slots **620** is configured such that when the RPM of the rotor **26** is decreased below a predetermined speed (e.g., low centrifugal force is imparted to the moveable locking blocks **700**), the moveable locking blocks **700** can slide radially inward due to gravity, spring force provided by the springs **320**, or any other appropriate source of centripetal force.

FIG. **7** is a perspective view of an example moveable locking block **700**. The moveable locking block **700** includes a dovetail section **710** and a block section **750**. The dovetail section **710** is configured to be assembled into, and partly constrained within a corresponding one of the dovetail slots **620** of the dovetail disk **600**, e.g., the dovetail shape permits the moveable locking block **700** to partly move along the dovetail slot **620** substantially without rotating or falling out. The dovetail section **710** includes a bore **712** that is substantially parallel to the dovetail and is formed in a radially inward face **714**. In use, the bore **712** engages a corresponding one of the springs **320**.

The block section **750** is configured with four vertical faces, arranged as a rhombus if viewed in cross-section, including a radially outward face **752**, a radially inward face **754**, a radially leading face **756**, and a radially trailing face **758**. The radially trailing face **758** is oriented substantially parallel relative to the orientation of the dovetail section, such that the radially trailing face **758** will be substantially aligned parallel to the path of travel of the moveable locking block **700** in one of the dovetail slots **620**. The radially outward face **752** is arranged substantially perpendicular to the radially trailing face **758**.

The radially leading face **756** is arranged substantially perpendicular to the radially outward face **752** and substantially parallel to the radially trailing face **758**. The radially leading face **756** extends radially inward a lesser distance than the radially trailing face **758**. The radially inward face **754** is configured with a taper that extends from the radially trailing face **758** to the radially leading face **756**. In some embodiments, the radially leading face **756** and/or the radially inward face **754** may be planar surfaces. In some embodiments, the radially leading face **756** and/or the radially inward face **754** may be planar and/or curved surfaces.

FIG. **8**A is a bottom perspective view of the example locking disk **800**. The locking disk **800** is configured as an outer ring **810** arranged concentrically about and connected to an inner ring **850**, partly separated by a cavity **802**. The inner ring **850** includes a collection of threads **812** about an outer radial surface **814**.

The inner ring **850** includes a central bore **851** sized to accommodate the driveshaft **210**. The inner ring **850** includes a collection of locking slots **816** and fastener holes **817** formed in a second longitudinal end **830***b*. Each of the locking slots **816** and fastener holes **817** is configured to accommodate and removably affix a corresponding one of the locking assemblies **1100**, as will be discussed further in the descriptions of FIGS. **11** and **12**A.

The outer ring **810** includes a collection of slots **852** arranged radially about the circumference of the outer ring **810**. Each of the slots **852** is configured to accommodate one of the lower wicker pads **900**.

Referring now to FIG. **8**B, a top perspective view of the example locking disk **800** is shown. A first longitudinal end **830***a* includes a collection of fixed locking blocks **860**. The collection of fixed locking blocks **860** extend longitudinally out from the first longitudinal surface **830***a*, and are arranged concentrically about the bore **851**. In embodiments, the number of the fixed locking blocks **860** may be equal to the number of moveable locking blocks **700**.

FIG. **8**C is an enlarged view of the region of FIG. **8**B indicated by the letter "A". The view includes one of the fixed locking blocks **860**. The fixed locking block **860** includes a radially outward face **852**, a radially leading face **856**, and a radially trailing face **858**. The radially leading face **856** is a generally planar surface arranged to contact the radially trailing face **758** of one of the moveable locking blocks **700** such that the faces **856** and **758** are substantially coplanar when in contact. The radially trailing face **858** and the radially outward face **852** are arranged in a tapered (e.g., wedge) or curved configuration such that the radially outward face **852** and the radially inward face **754** are substantially coplanar when in contact. The interactions among the faces **752-758** and **852-858** will be discussed further in the descriptions of FIGS. **14** and **15**.

FIG. **9** is a perspective view of an example of the collection of lower wicker pads **900**. The lower wicker pad **900** is a section of a ring having an inner radial surface **905** and an outer radial surface **910**. The outer radial surface has a taper from a first diameter **920***a* and first longitudinal end **930***a* to a second diameter **920***b* at a second longitudinal end **930***b*. The degree of this taper is substantially equal to a taper of the lower taper disk **1000**. The wicker pad **900** includes a collection of longitudinal wickers **950** on the outer radial surface **910**. In use, the longitudinal wickers **900** frictionally engage the stator **24**. The longitudinal wickers **950** are compressed against the stator **24** when the lower taper disk **1000** is threaded into the locking disk **800**. In some embodiments, four lower wicker pads **900** may be included in the anti-stall mechanism **300**, although any appropriate number may be used.

FIG. **10** is a perspective view of the example lower taper disk **1000**. The lower taper disk **1000** is a ring with a collection of threads **1010** arranged upon an inner surface **1005**. An outer surface **1007** of the lower taper disk **1000** is formed with a taper **1009** that progresses from a first diameter **1020***a* at a first longitudinal end **1030***a* and a second diameter **1020***b* larger than the first diameter **1020***a* at a second longitudinal end **1030***b*.

The threads **1010** are formed to mate with corresponding threads formed in the locking disk **800**. A collection of torque holes (not shown) are formed in the second longitudinal end **430***b*. In some implementations, the torque holes may accept the insertion of a tool. For example, a spanner wrench may be inserted into the torque holes to rotate the lower taper disk **1000** to thread or unthread the lower taper disk **1000** to or from the locking disk **800**. As the lower taper disk **1000** is assembled to the locking disk **800**, the lower wicker pads **900** are compressed between the lower taper disk **1000** and the stator **24**, causing the longitudinal wickers **1050** to frictionally engage the stator **24**.

FIG. **11** is a perspective view of one of the collection of the locking assemblies **1100**. The locking assembly **1100** includes a longitudinal support **1110**. The longitudinal support **1110** includes a flange **1120** at one end, a threaded section **1130** at the other end, and a fastener plate **1140** near its midpoint.

The flange **1120** is configured to fit into, and be at least partly constrained by, a corresponding one of the locking slots **616** or **816**. The fastener plate **1140** is configured to align a collection of fasteners **1150** (e.g., bolts) with the fastener holes **617** or **817**. A locking plate **1160** includes a bore (not shown) through which the threaded section **1130** is passed. A fastener **1170** (e.g., a nut) is threaded onto the threaded section **1130** to constrain the locking plate **1160** along the longitudinal length of the longitudinal support **1110**.

FIG. **12**A is a partial cutaway perspective view of the example anti-stall mechanism **300**. Visible in this view are the driveshaft **210**, the upper taper disk **400**, the dovetail disk **600**, several of the stopper pins **310**, two of the springs **320**, two of the moveable locking blocks **700**, the locking disk **800**, two of the lower wicker pads **900**, and two of the locking assemblies **1100**.

The moveable locking blocks **700** are shown assembled to the dovetail disk **600**. In their assembled configuration, the dovetail sections **710** are longitudinally constrained by a dovetail slot **620**. A corresponding one of the springs **320** is constrained between the dovetail disk **600** and the bore **712** (not visible in this view). The moveable locking blocks **700** are constrained from exiting the dovetail slots **620** by the stopper pins **310**.

The locking assemblies **1100** are shown assembled to the dovetail disk **600**. In their assembled configuration, the flanges **1120** are longitudinally constrained by the locking slots **616**, and the locking assemblies **1100** are constrained radially by passing the fasteners **1150** through the fastener plates **1140** and into the fastener holes **617** (not visible in this view).

The locking plates **1160** are placed over the threaded sections **1130** and are brought into contact with the first longitudinal end **430***a* of the taper disk **400**. The locking plates **1160** are removably constrained at these positions by threading the fasteners **1170** onto the threaded sections **1130** to bring the fasteners **1170** into contact with the locking plates **1160**.

FIG. **12**B is another perspective view of the example anti-stall mechanism **300**. In this view, it can be seen that the locking assemblies **1100** are assembled to the inner ring **850** of the locking disk **800** in a manner substantially similar to that described previously in regard to the locking assemblies **1100** and the dovetail disk **600**. The fasteners **1170** removably maintain contact between the locking plates **1160** and the lower taper disk **1000**.

FIG. **13**A is a cross-sectional side view of an example anti-stall mechanism **300** in a disengaged configuration. The disengaged configuration is exhibited when the driveshaft **210** is rotating at a speed that imparts sufficient centrifugal force upon the moveable locking blocks **700** to overcome the centripetal force provided by the springs **320**. Under such conditions, the moveable locking blocks **700** move radially outward to an orbit where the moveable locking blocks **700** do not contact the fixed locking blocks **860**.

FIG. **13**B is a cross-sectional side view of an example anti-stall mechanism in an engaged configuration. The engaged configuration is exhibited when the driveshaft **210** is rotating more slowly than the stator **24** and at a speed that imparts insufficient centrifugal force upon the moveable locking blocks **700** to overcome the centripetal force provided by the springs **320**. Under such conditions, the moveable locking blocks **700** will move radially inward where they may come into radial contact with the fixed locking blocks **860**.

FIGS. **14**A and **14**B are perspective views of the example anti-stall mechanism **300** in an engaged configuration. Several elements of the anti-stall mechanism **300** are hidden in this view in order to better illustrate the relationships between the moveable locking blocks **700** and the fixed locking blocks **860**. Referring to FIG. **14**A, one of the moveable locking blocks **700** and one of the fixed locking blocks **860** are highlighted within a region generally designated as “B”.

FIG. **14**B is an enlarged view of the region “B” of FIG. **14**A to better illustrate an example engagement between the moveable locking block **700** and the fixed locking block **860**. In situations in which the driveshaft **210** is spinning at less than a predetermined speed, the moveable locking block **700** will move radially inward to the illustrated position. If the rotational speed of the driveshaft **210**, and hence the moveable locking block **700**, is also less than or equal to the rotational speed of the stator **24**, and hence the fixed locking block **860**, the radially leading face **856** will contact the radially trailing face **758**.

The radially leading face **856** is a generally planar surface arranged to contact the radially trailing face **758** of one of the moveable locking blocks **700** such that the faces **856** and **758** are substantially coplanar when in contact. While in the engaged configuration, rotational energy from the stator **24** can be transferred to the driveshaft **210** through the fixed locking blocks **860** to the moveable locking blocks **700**.

FIGS. **15**A and **15**B are simplified perspective views of the example anti-stall mechanism **300** exiting an engaged configuration. Several elements of the anti-stall mechanism **300** are hidden in this view in order to better illustrate the relationships between the moveable locking blocks **700** and the fixed locking blocks **860**. Referring to FIG. **15**A, one of the moveable locking blocks **700** and one of the fixed locking blocks **860** are highlighted within a region generally designated as “C”.

FIG. **15**B is an enlarged view of the region “C” of FIG. **15**A to better illustrate an example disengagement between the moveable locking block **700** and the fixed locking block **860**. In situations in which the rotational speed of the driveshaft **210**, and hence the moveable locking block **700**, is greater than the rotational speed of the stator **24**, and hence the fixed locking block **860**, the radially leading face **756** will contact the radially trailing face **858**.

The radially leading face **756** and the radially trailing face **858** are configured such that contact between these two faces will urge the moveable block **700** radially outward. The radially trailing face **858** and the radially outward face **852** are arranged in a tapered (e.g., wedge) or curved configuration such that the radially outward face **852** and the radially inward face **754** are substantially coplanar when in sliding contact, and further urge the moveable block **700** outward and out of contact with the fixed locking block **860**.

FIG. **16** is a flow diagram of an example process **1600** for the operation of an example anti-stall mechanism, such as the anti-stall mechanism **100** or **300** of FIG. **1** or **3**. At **1610**, a drilling assembly and a locking clutch are provided. The drilling assembly includes a rotatable housing coupled to a stator of a drilling motor positionable in a wellbore and a rotatable output shaft coupled to a driveshaft of the drilling motor, said rotatable output shaft having a central longitudinal axis aligned with a central longitudinal axis of the rotatable housing. The locking clutch includes a plurality of movable locking blocks slidably coupled to the rotatable output shaft. The movable locking blocks are slidable radially inwardly and outwardly with respect to a central longitudinal axis of the rotatable output shaft, and are spaced apart circumferentially about the rotatable output shaft. Each of the locking blocks has a first contacting face and a second contacting face. A plurality of fixed locking blocks are coupled to the rotatable housing, and are positioned radially around the output shaft and spaced apart circumferentially about the interior of the rotatable housing a distance sufficient to receive one of the movable locking blocks when it moves inwardly toward the central axis of the rotatable output shaft. Each locking block has a first contacting face and a second contacting face. In some embodiments, the drilling assembly can be the driveshaft **210** and the stator **24** of FIG. **1**, and the locking clutch can be the anti-stall mechanism **100** or **300**.

At **1620**, the drilling assembly and the locking clutch are positioned in the wellbore. For example, the drill string **20** and the anti-stall mechanism **100** can be lowered into the wellbore **60**.

At **1630**, the stator of the drilling motor is rotated at a first rotational speed. At **1640**, the rotor of the drilling motor can be rotated relative to the stator of the drilling motor at a second rotational speed greater than the first speed. For example, the rotor **26** may be rotated relatively faster than the stator **24**.

At **1640**, the movable locking blocks are moved outwardly from the central axis of the rotatable output shaft by centrifugal force sufficient to overcome a biasing force applied by a biasing member to the movable locking blocks. For example, rotation of the driveshaft **210** may impart rotation of the dovetail disk **600** and the moveable locking blocks **700** that can cause centrifugal forces acting on the moveable locking blocks **700** to overcome the biasing force provided by the springs **320**.

At **1650**, the speed of rotation of the rotatable output shaft is reduced relative to that of the rotatable housing, resulting in reduced centrifugal force on the movable locking blocks. At **1660**, the movable locking blocks are moved inwardly toward the central axis within the downwardly tapered dovetail joints with the biasing force applied to the movable locking blocks. For example, as the driveshaft **210** slows, the forces of gravity and/or the springs **320** may become relatively greater than the centrifugal forces acting upon the moveable locking blocks **700**, causing them to move radially inward along the dovetail slots **620**.

At **1670**, the movable locking blocks are engaged with the fixed locking blocks. For example, in the engaged configuration illustrated in FIGS. **14**A-**14**B, the moveable locking block **700** is engaged with the fixed locking block **860**. At **1680**, torque is transferred from the rotatable housing via the locking blocks to the rotatable output shaft. For example, while in the engaged configuration shown in FIGS. **13**B and **14**A-**14**B, rotational energy from the stator **24** can be transferred to the driveshaft **210** through the fixed locking blocks **860** to the moveable locking blocks **700**.

Although a few implementations have been described in detail above, other modifications are possible. For example, the logic flows depicted in the figures do not require the particular order shown, or sequential order, to achieve desirable results. In addition, other steps may be provided, or steps may be eliminated, from the described flows, and other components may be added to, or removed from, the described systems. Accordingly, other implementations are within the scope of the following claims.

What is claimed is:

1. A locking clutch to selectively transmit torque from a rotatable stator coupled to a drilling motor positionable in a wellbore and a rotatable output shaft coupled to a rotatable rotor of the drilling motor, said locking clutch comprising:

a plurality of slidable locking blocks slidably coupled to the rotatable output shaft, said slidable locking blocks slidable radially inwardly and outwardly with respect to a central longitudinal axis of the rotatable output shaft, said slidable locking blocks spaced apart circumferentially about the rotatable output shaft, each of said slidable locking blocks having a first contacting face and a second contacting face; and

a plurality of fixed locking blocks coupled to the rotatable stator, said fixed locking blocks positioned radially around the rotatable output shaft and spaced apart circumferentially about an interior of the rotatable stator a distance sufficient to receive one of the slidable locking blocks when it moves inwardly toward the central axis of the rotatable output shaft, each of said fixed locking blocks having a first contacting face and a second contacting face.

2. The locking clutch of claim **1** further including a dovetail disk coupled to the rotatable output shaft, said dovetail disk having a plurality of dovetail grooves, each of said grooves configured to slidably receive a dovetail extension of one of the slidable locking blocks.

3. The locking clutch of claim **2** wherein each of the dovetail grooves is inclined upward from a plane disposed perpendicular to the central axis of the rotatable output shaft.

4. The locking clutch of claim **1** further including a biasing member coupled to each of the slidable locking blocks, said biasing member configured to slidably move each of the slidable locking members inwardly toward the central longitudinal axis of a rotatable output shaft when centrifugal force acting on each of the slidable locking block is reduced.

5. The locking clutch of claim **2** wherein the dovetail disk further includes a plurality of first circumferential threads about an inner radial surface, and the locking clutch further including:

a first taper disk having a plurality of second circumferential threads about an outer radial surface and formed to be threadably mated with the first circumferential threads, and a tapered inner radial surface having a first diameter at a first longitudinal end and a second diameter different from the first diameter at a second longitudinal end opposite the first longitudinal end; and,

a first wicker pad having a tapered outer radial surface having a third diameter at a third longitudinal end and a fourth diameter different from the third diameter at a fourth longitudinal end opposite the third longitudinal end, and an inner radial surface having a plurality of longitudinal grooves and peaks, the peaks sized to contact an outer radial surface of the rotatable output shaft.

6. The locking clutch of claim **1** further including a locking disk coupled to the rotatable stator, said locking disk having the plurality of fixed locking blocks positioned radially about a longitudinal end face of the locking disk.

7. The locking clutch of claim **6** wherein the locking disk further includes a plurality of third circumferential threads about an inner radial surface, and the locking clutch further including:

a second taper disk having a plurality of fourth circumferential threads about an inner radial surface and formed to be threadably mated with the third circumferential threads, and a tapered outer radial surface having a fifth diameter at a fifth longitudinal end and a sixth diameter different from the fifth diameter at a sixth longitudinal end opposite the fifth longitudinal end; and a second wicker pad having a tapered inner radial surface having a seventh diameter at a seventh longitudinal end and an eighth diameter different from the seventh diameter at an eighth longitudinal end opposite the seventh longitudinal end, and an outer radial surface having a plurality of longitudinal grooves and peaks, the peaks sized to contact an inner radial surface of the rotatable stator.

8. The locking clutch of claim **1**, wherein:

the first contacting face of each slidable locking block and the first contacting face of each fixed locking block are oriented to promote engagement between the slidable locking blocks and the fixed locking blocks when the first contacting face of each slidable locking block and the first contacting face of each fixed locking block are in contact; and,

the second contacting face of each slidable locking block and the second contacting face of each fixed locking block are oriented to urge a corresponding slidable locking block to move outwardly away from the central axis of the rotatable output shaft and promote disengagement of the slidable locking blocks from the fixed locking blocks when the second contacting face of each slidable locking block and the second contacting face of each fixed locking block are in contact.

9. The locking clutch of claim **1**, wherein the drilling motor is a positive displacement Moineau type motor, wherein the rotatable stator of the locking clutch is coupled to the housing of the drilling motor and the rotatable output shaft is coupled to the rotatable rotor of the drilling motor.

10. The locking clutch of claim **1**, wherein the drilling motor is turbine type motor, wherein the rotatable stator of the locking clutch is coupled to the housing of the drilling motor and the rotatable output shaft is coupled to the rotatable rotor of the drilling motor.

11. A method of selectively transmitting torque from a rotatable stator to a rotatable output shaft positioned in a wellbore, said method comprising:

providing a drilling assembly including:

a rotatable housing coupled to a drilling motor positionable in a wellbore and a rotatable output shaft coupled to a rotatable rotor of the drilling motor, said rotatable output shaft having a central longitudinal axis aligned with a central longitudinal axis of the rotatable stator;

providing a locking clutch including:

a plurality of slidable locking blocks slidably coupled to the rotatable output shaft, said slidable locking blocks slidable radially inwardly and outwardly with respect to a central longitudinal axis of the rotatable output shaft, said slidable locking blocks spaced apart circumferentially about the rotatable output shaft, each of said locking blocks having a first contacting face and a second contacting face; and,

a plurality of fixed locking blocks coupled to the rotatable stator, said fixed locking blocks positioned radially around the output shaft and spaced apart circumferentially about the interior of the rotatable stator a distance sufficient to receive one of the slidable locking blocks when it moves inwardly toward the central axis of the rotatable output shaft, each said locking block having a first contacting face and a second contacting face;

positioning the drilling assembly and the locking clutch in the wellbore;

rotating the rotatable stator at a first rotational speed;

rotating the rotatable rotor of the drilling motor relative to the rotatable stator at a second rotational speed greater than the first speed; and,

moving the slidable locking blocks outwardly from the central axis of the rotatable output shaft by centrifugal force sufficient to overcome a biasing force applied by a biasing member to the slidable locking blocks.

12. The method of claim **11** further comprising:

reducing the speed of rotation of the rotatable output shaft relative to the rotatable stator resulting in reduced centrifugal force on the slidable locking blocks; and

moving the slidable locking blocks inwardly toward the central axis within a downwardly tapered dovetail joints with the biasing force applied to the slidable locking blocks.

13. The method of claim **12** further comprising:

engaging the slidable locking blocks with the fixed locking blocks;

transferring torque from the rotatable stator via the locking blocks to the rotatable output shaft.

14. The method of claim **12** further including moving the slidable locking blocks out of the locked position to allow the rotatable rotor of the drilling motor to rotate independent of the rotatable stator.

15. The method of claim **11**, wherein the drilling motor is a positive displacement type motor, wherein the rotatable stator of the locking clutch is coupled to the rotatable stator of the drilling motor and the rotatable output shaft is coupled to the rotatable rotor of the drilling motor.

16. The method of claim **11**, wherein the drilling motor is turbine type motor, wherein the rotatable stator of the locking clutch is coupled to the housing of the drilling motor and the rotatable output shaft is coupled to the rotatable rotor of the drilling motor.

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